

Prenatal Exposure to Polycyclic Aromatic Hydrocarbons (PAHs) & Respiratory Symptoms in Young Infants

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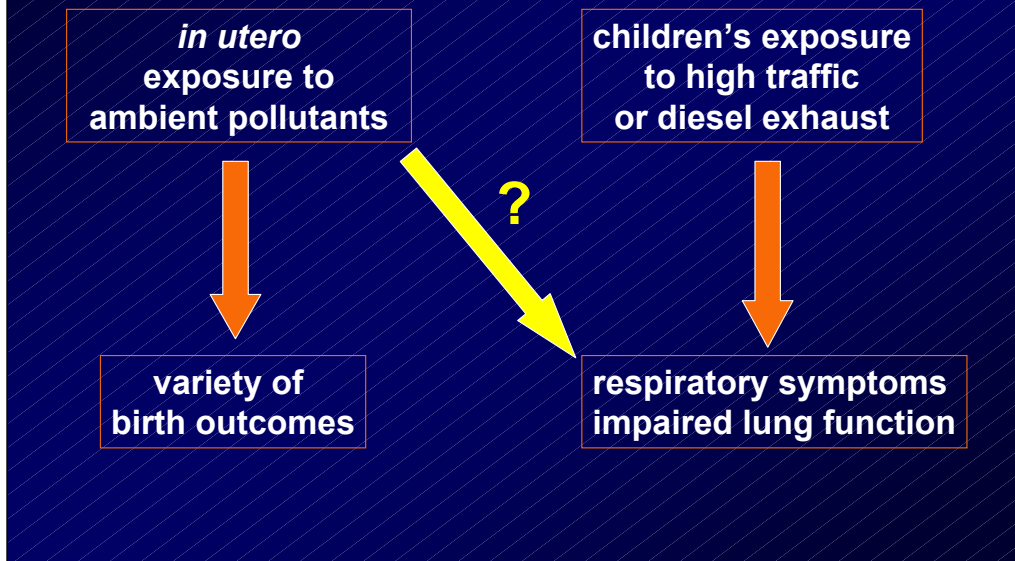


Air Resources Board

California Environmental Protection Agency

Thank you Ms. Witherspoon. Good morning Madame Chairman and members of the Board. In today's Health Update we will discuss the results of an epidemiological study that evaluates the possible link between prenatal exposures to air pollution and respiratory health in newborns.

Background



There is a growing body of evidence supporting a causal link between air pollution exposures early in life and adverse effects in infants and children. What researchers have shown us thus far is that exposure to certain ambient air pollutants during pregnancy may increase the risk of sudden infant death, low birth weight, and a variety of other birth outcomes. Likewise, researchers have demonstrated that air pollution can impact the respiratory health of children as they grow and develop.

The missing puzzle piece, however, is *if* or *how* exposures to the fetus during pregnancy are related to the respiratory health of infants and children. The study we will review today is the first to examine this potential relationship.

Study Design

- Study in Harlem, South Bronx, and Washington Heights (New York City)
 - Subjects predominantly Latina or African American
 - Range of median household incomes: \$12,000 - \$22,000
 - High level of combustion-generated pollution
- Exposure assessment:
 - Personal behaviors questionnaire
 - Personal monitoring during third trimester of pregnancy
 - Mother and newborn cotinine levels
- Newborns followed prospectively



Miller et al. (2004). Chest 126(4): 1071-1078

This is an epidemiological study conducted by Dr. Rachel Miller and her colleagues at the Columbia Center for Children’s Environmental Health. Over 300 nonsmoking pregnant women were recruited from prenatal clinics and hospitals in the Washington Heights, Harlem, and South Bronx neighborhoods of New York City. These communities are largely Latino and African American, with median household incomes ranging between \$12,000 to \$22,000 a year.

As seen on the map, the neighborhoods studied are at the center of a large metropolitan region inundated with commercial truck traffic, diesel exhaust from bus depots, and various air contaminants generated from waste incinerators, two power plants, and the takeoff and landing corridors of LaGuardia Airport.

For the study, exposure assessment was conducted using three methods. First, questionnaires were given to each participant in the third trimester of pregnancy and throughout the infant's first two years of life which detailed secondhand smoke, heating and cooking sources, and other relevant exposures. Second, individual-level air sampling data were collected for each participant in her third trimester. Each woman carried a portable backpack monitor for 48 hours that measured the levels of particles, as well as semivolatile vapors and aerosols. Lastly, blood from the mothers was collected within 1 day after giving birth, and umbilical cord blood was collected at the time of delivery. These blood samples were analyzed for plasma cotinine, a metabolite of tobacco that is used as a surrogate measure of exposure to direct or environmental tobacco smoke.

After delivery, the health of each baby was followed closely, with special attention paid to respiratory problems and early signs of asthma.

Results

- Every pregnant woman had measurable PAH exposure (average = 3.65 ng/m³; range 0.27 - 36.47 ng/m³), a highly toxic component of combustion pollution
- 33% - 45% of infants were exposed to environmental tobacco smoke (ETS)
- Prenatal PAH exposure combined with postnatal ETS exposure resulted in 25-60% more respiratory symptoms and increased severity with infant age

PAHs may act synergistically with ETS to worsen respiratory health of infants

The investigators analyzed the personal air samples for levels of polycyclic aromatic hydrocarbons, also known as PAHs. PAHs were the focus of this study because they are components of combustion air pollution, such as diesel exhaust, residential heating, and tobacco smoke. They are also highly toxic and can bind to DNA and certain growth factors.

Results from this study suggest that the pregnant women had universal exposure to one or more PAHs, averaging 4 ng/m³. Exposure to PAHs varied significantly among the participants, however the values were comparable to concentrations measured in California.

Questionnaire results and plasma cotinine analysis showed that at least one-third of mothers and newborns were exposed to environmental tobacco smoke.

Neither prenatal exposure to PAHs nor environmental tobacco smoke, alone, were associated with discernable increases in respiratory symptoms.

However, infants exposed to both PAHs during pregnancy *and* environmental tobacco smoke after birth experienced between 25-60% more respiratory symptoms. These symptoms also worsened as the infants got older.

The implication being, that exposure to PAHs exacerbated or somehow worked in concert with environmental tobacco smoke to affect the respiratory health of infants.

Other factors, like quality of housing, most likely varied between participants. If these factors had a major influence on respiratory symptoms, we would have expected to see an effect in this study. However, no such effects were reported.

Other Prenatal Effects of Air Pollution

| Health Outcome | Ambient Pollutant | Citation (Location) |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Low birth weight | SO ₂ , TSP, CO, or TSP + SO ₂ , or SO ₂ + NO ₂ + PM ₁₀ | Wang et al. 1997 (Beijing) Bobak 2000 (Czech Rep) Rogers et al 2000 (US) Maisonet et al. 2001 (US) Lin et al. 2001 (Taiwan) |
| Premature birth | SO ₂ , NO ₂ , PM ₁₀ , CO, ozone | Xu et al. 1995 (Beijing) Bobak 2000 (Czech Rep) Ritz et al. 2000 (So. Calif) |
| Heart defects | CO, ozone | Ritz et al. 2002 (So. Calif) |
| Neonatal respiratory deaths | TSP, SO ₂ , NO _x | Bobak & Leon 1999 (Czech Rep) |

The results from this study add to our knowledge of prenatal effects of air pollution and also complement other published research. For example, a number of investigators have considered the link between prenatal exposure to air pollution and various birth outcomes, as summarized in this table. Two Southern California studies, conducted with the assistance of Scott Fruin of ARB's Research Division, evaluated the association between ambient air pollution and heart defects and preterm birth.

These studies are important to our understanding of the impact of ambient air pollutants on pregnancy, and underscore the importance of considering all life stages when assessing the adverse health effects of exposure to air pollutants.

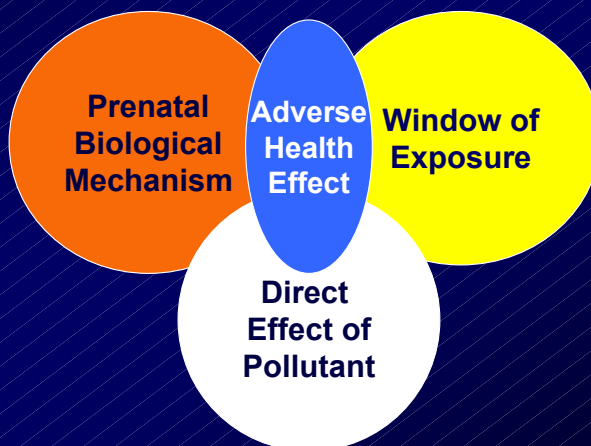
Selected Sources for Prenatal Effects of Health Pollution:

- Wang et al. (1997). Environ Health Perspect 105:514-520.
- Bobak (2000). Environ Health Perspect 108:173-176.
- Rogers et al. (2000). Am J Epidemiol 151:602-613.
- Maisonet et al. (2001). Environ Health Perspect 109 (suppl 3):351-356.
- Lin et al. (2001). J Toxicol Environ Health 63:565-574.
- Xu et al. (1995). Arch Environ Health 50:407-415
- Ritz et al. (2000). Epidemiol 11:502-511.
- Ritz et al. (2002). Am J Epidemiol 155:17-25.
- Bobak & Leon (1999). Occup Environ Med 56:539-543.

Conclusions & Research Implications

- First study suggesting link between prenatal exposure to ambient air pollution and respiratory health of infants

Potential Research Directions for Prenatal Effects



There are limitations to the study we reviewed today, such as when the air sampling was conducted and the absence of a control group. However, this is the first study to consider an association between prenatal exposure to air pollution and the respiratory health of developing infants.

We are beginning to understand that fetuses and infants may be particularly sensitive to a variety of environmental insults, including air pollution. This sensitivity may be due in part to a fetus's vulnerability during specific windows of development, or because of specific biological mechanisms associated with pregnancy, or because of a direct effect of individual pollutants.

The research described in this Health Update is an example of how each of these factors might influence the respiratory health in the very young. Future research in these areas will likely yield additional important information on how early exposures to air pollution can affect respiratory health later in life.

Thank you for your attention, and I would be happy to answer any questions.